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ABSTRACT

Research has shown sex differences in performance favoring males are likely to be reported on cognitive tasks requiring spatial skills. It has also been suggested that the reason why individuals who describe themselves as masculine also tend to do well on spatial tasks may be a function of activity preference. To examine the relationship among college students' spatial performance, spatial activity preferences, and self-descriptions, college men (N=144) and college women (N=191) were tested in three studies on one of two spatial tasks, and surveyed on their participation in 81 space-related activities. In all three studies, better spatial performance was associated with higher self-reports of participation in masculine, but not feminine, spatial activities. In the second and third studies, participants also took the Bem Sex-Role Inventory. Women and men who were masculine did better on the spatial tasks than did women and men who were feminine. Results suggest that even small differences in activity preferences may help explain the commonly observed sex differences on spatial tasks. (Author/JAC)

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Spatial Performance, Activity Preferences, and Masculinity-Femininity

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Spatial Performance, Activity Preferences, and Masculinity-Femininity

Abstract

One of the socialization explanations for sex differences on spatial tasks was investigated in three studies. College men and women were tested on one of two spatial tasks, and surveyed on their participation in 81 space-related activities. In all three studies, better spatial performance was associated with higher self-reports of participation in masculine, but not feminine, spatial activities. In the second and third studies, subjects were also given the Bem Sex-Role Inventory. Women and men who were masculine did better on the spatial tasks than did women and men who were feminine. The implications for the study of cognitive sex differences were discussed.

Spatial Performance, Activity Preferences, and Masculinity-Femininity

Sex differences in performance favoring males are likely to be reported on cognitive tasks requiring spatial skills (e.g., Wittig & Petersen, 1979). It has been argued that the stereotyping of spatial (and mathematical) tasks as masculine hinders girls' acquisition of spatial skills (e.g., Nash, 1979). Consistent with this argument, both females and males who describe themselves as masculine do better on spatial tasks than females and males who describe themselves as feminine (e.g., Jamison & Signorella, 1980).

Recently, Newcombe, Bandura, and Taylor (in press) showed that performance on the Differential Aptitudes Space Relations Test (DAT) was related to preferences for spatial activities. In addition, they found more individual masculine than feminine or neutral activities were related to spatial performance. As a result, Newcombe et al. suggested that the reason why individuals who describe themselves as masculine also tend to well on spatial tasks may be a function of activity preferences.

Three studies are reported which examine the relationships among college students' spatial performance, spatial activity preferences, and self-descriptions using stereotypically masculine and feminine characteristics. College students were tested to insure that sufficient numbers of women with high spatial performance would be included in the sample. Two different spatial measures were used: the horizontality task (Piaget & Inhelder, 1956), which correlates most highly with measures of field independence-dependence (e.g., Liben, 1978); and the Card Rotations Test (French, Ekstrom, & Price, 1963), which assesses mental rotation performance.

Study 1 provided pilot information on the responses of students at Eastern Michigan University to the spatial activity questionnaire developed by Newcombe et al. (in press). Students were also given the horizontality task as the measure of spatial performance. In the two major studies (2 & 3), students were given the spatial activity questionnaire, one of the two spatial measures, and the Bem Sex-Role Inventory (Bem, 1974). It was hypothesized that women and men high in spatial performance would report participating in more spatial activities (particularly masculine ones) than women and men low in spatial performance. In addition, it was hypothesized that women

and men high in spatial performance would describe themselves as more masculine than women and men low in spatial performance.

STUDY 1

Method

Subjects

The subjects were 74 women and 67 men from general psychology classes at Eastern Michigan University. They volunteered for the study either as a class requirement or for extra credit.

Materials

Horizontality task. Horizontality performance was assessed using a paper-and-pencil task. Five-page booklets were constructed, with each page containing a drawing of a water bottle. On the first page, a sample bottle in the upright position (90 degrees) was presented with the water-line drawn correctly. Each of the remaining four pages contained one bottle without a water line, tipped at 25, 50, 130, and 155 degrees.

Spatial Activity Questionnaire. The questionnaire used to assess spatial activity participation was developed by Newcombe et al. (in press). The questionnaire consists of 40 judged masculine, 21 judged feminine, and 20 judged neutral activities, presented in randomized order. At the top of the questionnaire was a 7-point scale, anchored by "never participated in the activity" (1) and "participated in the activity more than once a week" (7). A complete list of the items is contained in Newcombe et al. (in press).

Procedure

Subjects were tested in small groups by a female experimenter. Approximately one-half of the subjects received the horizontality task first, while one-half received the spatial activity questionnaire first.

For the horizontality task, subjects were each given a booklet and told to look at the sample bottle on the first page, described as one-half full of water. The subjects were told that for the remaining four bottles they were to draw the water line on the bottle, imagining that the bottle was one-half full of water and that the bottle cap

was on tightly.

For the spatial activity questionnaire, subjects were asked to indicate how often they participated in each activity by using the 7-point scale at the top of the page. They were also told that seasonal activities should be given a 7 if the subjects participated in those activities more than once a week during the season.

Scoring

Subjects' water-level drawings were scored with a protractor for degrees of deviation from horizontal. A drawing was considered correct if it was within five degrees of horizontal. Although a criterion of within 10 degrees of horizontal is often used for drawings, especially with young children (e.g., Liben & Golbeck, 1980), 10 degrees is too lenient for college students. An error of 10 degrees can be detected by inspection alone.

Results and Discussion

The reliabilities, as measured by coefficient alpha, were .92, .80, and .79, for the masculine, feminine, and neutral subscales, respectively. Item-total correlations were computed for the men's and women's responses separately. In general, the individual items showed moderate correlations with total score in both sexes. There were only three items which did not correlate with total score. Two of the items were masculine (fencing, glass blowing) and one neutral (jumping horses).

In all of the following comparisons between the sexes, the men's scores have been subtracted from the women's. Thus, if women score higher, the value of the statistic will be positive; if men score higher the value will be negative.

For total spatial activity score, there was a sex difference in self-reports of participation, $t(139) = -2.38$, $p < .05$ (women = 170, men = 185). Men ($M = 101$) also had a higher preference for the masculine activities than did women ($M = 73$), $t(139) = -7.60$, $p < .01$, while women ($M = 46$) had a higher preference for the feminine activities than did men ($M = 30$), $t(139) = 10.04$, $p < .01$. On the neutral activities, however, women ($M = 52$) and men ($M = 54$) did not differ in their preferences, $t(139) = -.98$. The pattern of responses by the sexes was the same as found by Newcombe et al. (in press) in all respects except one. Newcombe et al. did not find a sex difference

in total activity score.

Subjects were classified as high in spatial performance if they were correct on all four bottles. Performance on the horizontality task was very poor, with only 14% of the women and 21% of the men drawing four correct water lines. Although the trend was toward better performance by men, the sex differences was not significant, $z = -1.10$, $p < .15$. This is surprising given that past research with high school and college students has consistently found significant sex differences favoring males (e.g., Jamison & Signorelli, 1980; Liben, 1978).

To examine the relationship between spatial activity participation and performance, correlations were computed between spatial activity scores and horizontality performance classification (0 = low, 1 = high). There were significant correlations between horizontality performance and total spatial activity score, $r(139) = .24$, $p < .01$, masculine activity score, $r(139) = .19$, $p < .05$, and neutral activity scores, $r(139) = .27$, $p < .01$. As Newcombe et al. (in press) found, feminine activities contributed little to the prediction of spatial performance.

STUDY 2

The results of the first study demonstrated that self-reports of participation in spatial activities were related to performance on the horizontality task. The purpose of the second study was to replicate the findings, and in addition, examine subjects' gender-stereotyped self-descriptions in relation to their spatial performance. To assess horizontality performance, an apparatus was used which allows subjects to adjust the water line in a bottle, and to receive feedback when the water line is not correctly placed. The purpose of using the apparatus and providing feedback was not to provide training per se, but rather to make sure that the best possible performance was being elicited from the subjects.

Method

Subjects

The subjects were 42 women and 37 men recruited from general psychology classes at Eastern Michigan University. They volunteered for the study as a class requirement or for extra credit.

Apparatus and Materials

Knowledge of the horizontality principle was assessed using a water-level apparatus which was comprised of two parts: a cylindrical bottle half-filled with red water, mounted on an axle to allow for rotation, and a second bottle (the pretend bottle) mounted on a cardboard disc which could also be rotated. Visible through the pretend bottle was a half-red disc which could be rotated to designate the water line.

On each trial, the subject was asked to imagine the water line orientation in the covered real bottle, and to predict the water line by adjusting the red disc behind the pretend bottle.

Activity preference was measured using the same questionnaire as in Study 1 (Newcombe et al., in press), minus the three items (two masculine, one neutral) which did not significantly correlate with total score for either sex.

Self-descriptions with gender-stereotyped adjectives were obtained using the Bem Sex-Role Inventory (BSRI; Bem, 1974), which contains 60 personality characteristics (20 each masculine, feminine, and neutral). Subjects rated themselves on each characteristic using a 7-point scale.

Procedure

Subjects, tested individually by a female experimenter, were instructed in the use of the apparatus and were asked to make predictions about the orientation of the water in the real bottle tilted to one of four positions (30, 60, 120, and 150 degrees). Those who were able to place the water line within 5 degrees of horizontal on all four bottle angles were scored as knowing the principle. Subjects who made one to four errors were given feedback on a second block of four trials, with the same angles presented in a different order. Subjects were asked to remove the cover of the real water bottle following each prediction, compare their prediction to the real bottle, and correct any discrepancies. They were then retested on the same four angles, but without any feedback. After all adjustments had been completed, the subjects were then asked how they knew where to put the pretend water line, and what the rule was for how water acts in a bottle.

Following the horizontality task, subjects were given the activity questionnaire

and the BSRI.

Scoring

Horizontality task. To examine the validity of requiring four correct responses for classification into the high spatial performance category, subjects' responses to the two questions about the water line were compared with the number of correct adjustments. Ninety-four percent of those who got all four correct were also able to explain correctly what they did (e.g., the water is always horizontal, or level, or parallel to the ground). None of the subjects who missed 1-4 angles were able to explain correctly the horizontality principle.

Bem Sex-Role Inventory. Total scores on the masculine and feminine adjectives were obtained. To classify subjects as high or low on either scale, a median of 98 was used. This median was obtained from the testing of over 200 men and women on the BSRI at Eastern Michigan (Signorella, 1979). A standard median was used to facilitate comparisons across studies.

Results and Discussion

Unlike Study 1, there was no overall sex difference in self-reports of participation in spatial activities, $t(77) = -1.16$ (men = 164, women = 174). Once again, however, men ($M = 92$) preferred more of the masculine activities than did women ($M = 69$), $t(77) = -4.35$, $p < .01$, while women ($M = 46$) preferred more of the feminine activities than did men ($M = 33$), $t(77) = 5.47$, $p < .01$. There were no sex differences in preferences for the neutral activities, $t(77) = -.45$ (women = 48, men = 49).

Using the criterion of four correct for classification as high in spatial performance, there was a significant difference in the proportions of women (.31) and men (.57) classified as high spatial, $z = -2.33$, $p < .01$. There was a significant correlation between spatial performance (0 = low, 1 = high) and participation in the masculine activities, $r(77) = .27$, $p < .05$, but not between horizontality performance and total activity scores, $r(77) = .18$, feminine scores, $r(77) = -.06$, or neutral scores, $r(77) = .07$.

The masculine and feminine scores from the BSRI were also correlated with horizontality performance. There was a significant correlation between horizontality

performance and feminine score, $r(77) = -.27$, $p < .05$, but not masculine score, $r(77) = .10$. This tendency for less feminine individuals to do better on the spatial task can also be seen when subjects are classified as high or low on the masculine and feminine scales using the median of 98. A sex (male, female) X masculine classification (high, low) X feminine classification (high, low) X horizontality performance (high, low) log-linear analysis was done. There was a significant interaction between feminine classification and horizontality performance, chi-squared (1) = 7.94, $p < .01$. A majority of those men and women who could do the horizontality task were low on the feminine scale (76%), whereas a majority of those who could not do the horizontality task were high on the feminine scale (62%). Thus, masculine (high masculine, low feminine) and undifferentiated (low masculine, low feminine) individuals did better on the spatial task than did feminine (low masculine, high feminine) and androgynous (high masculine, high feminine) individuals.

STUDY 3

Since the hypothesized relationships were found between horizontality performance and spatial activity participation, and between horizontality performance and BSRI scores, the third study was conducted to replicate and extend the findings to a different measure of spatial performance.

Method

Subjects

The subjects were 75 women and 40 men recruited from general psychology classes at Eastern Michigan University. They volunteered for the study either as a class requirement or for extra credit.

Materials

This study used one page of the Card Rotations Test (CRT; Frenc, Ekstrom, & Price, 1963) as the measure of spatial performance. This task requires subjects to decide whether each of eight two-dimensional figures in a row is the same or different from a standard. Some figures differ only in their orientation on the page, while different figures are mirror image reversals.

The spatial activity scale, minus the three items, and the BSRI were once again

used.

Procedure

Subjects were tested in small groups by a female experimenter. The order of presentation of tasks was randomized between sessions.

For the CRT, subjects were given four minutes to complete as many of the figures as possible. The BSRI and spatial activity questionnaire were administered using the same instructions as in the previous studies.

Scoring

A total score for the CRT was computed by subtracting the number incorrect from the number correct (total possible score = 112). Those with a score of 63 or greater (upper one-third of the distribution) were classified as high in spatial performance. This distribution cut-off was chosen because the mean score in this sample (57) was below that found in two studies in Michigan with junior high school students (Jamison & Signorella, Note 1; Signorella & Jamison, 1978).

Results and Discussion

The pattern of responses by women and men to the spatial activity questionnaire duplicated that found in Study 2 and by Newcombe et al. (in press). Women ($M = 165$) and men ($M = 174$) did not differ in their total activity scores, $t(113) = 1.34$, $p < .01$, or in their neutral scores, $t(113) = -.12$ (women = 50, men = 50). Men ($M = 93$) had a greater preference for masculine activities than did women ($M = 68$), $t(113) = -6.71$, $p < .01$, while women ($M = 46$) had a greater preference for feminine activities than did men ($M = 30$), $t(113) = 6.65$, $p < .01$.

There was a significant difference in the proportions of women (.33) and men (.50) classified as high in spatial performance, $z = -1.79$, $p < .05$. When mean scores on the CRT were compared, however, women ($M = 56$) and men ($M = 59$) did not differ, $t(113) = -.88$.

The patterns of correlations between spatial activity performance (0 = low, 1 = high) and spatial activity scores were the same as in Study 1. Spatial performance was significantly correlated with total activity score, $r(113) = .21$, $p < .05$, masculine activity score, $r(113) = .22$, $p < .05$, and neutral activity score, $r(113) =$

.20, $p < .05$, but not with feminine activity score, $r(113) = .01$.

As in Study 2, BSRI score was a significant predictor of spatial performance. In the present study, however, BSRI masculine score was significantly correlated with spatial performance, $r(113) = .25$, $p < .01$, but BSRI feminine score was not, $r(113) = -.03$. Individuals were also classified as high or low on the masculine and feminine scales using the median of 98. A sex (male, female) X masculine classification (high, low) X ⁿfeminine classification (high, low) X CRT performance (high, low) log-linear analysis was done. There was a significant interaction between masculine classification and spatial performance, chi-squared (1) = 7.59, $p < .01$. A majority of those high in spatial performance were also high on the masculine scale (71%), while a majority of those low in spatial performance were also low on the masculine scale (58%). Thus, masculine and androgynous individuals did better on the spatial task than did feminine or undifferentiated individuals.

General Discussion

The results of the three studies have shown a relationship between greater participation in spatial activities and better performance on two different spatial tasks. In all samples, masculine activities were related to spatial performance, and in two samples, neutral activities were related to spatial performance. In no case, however, did the feminine activities predict performance on spatial tasks. The predicted difference between masculine and feminine activities suggests that the stereotyping of spatial tasks and space-related activities may be important in understanding sex differences in spatial performance. The failure of feminine (and sometimes neutral) activities to predict spatial performance also suggests that better spatial performance is not related to a general tendency to participate in more activities.

BSRI scores were significantly related to both horizontality and CRT performance. As has been found in other research (e.g., Jamison & Signorella, 1980; Nash, 1975), those males and females who were classified as masculine did better than those classified as feminine. In contrast, the performance of androgynous and undifferentiated individuals was inconsistent across Studies 2 and 3, and has not been

consistent across other research either (Jamison & Signorella, 1980; Newcombe & Bandura, in press; Signorella & Jamison, 1978). Thus, the evidence is strongest for the contention that masculine individuals do better on spatial tasks than feminine individuals. Since masculine activities most consistently predict spatial performance, it is possible that a masculine identity leads one to choose activities that are also masculine, and that the activity choices eventually affect performance.

These results suggest that future research on sex differences in spatial performance should take into account individuals' experiences with spatial activities. Although the relationship between activity preferences and spatial performance was not large, the relationship between sex and spatial performance typically is not large, either. For example, in the present research, masculine activity preferences accounted for 4%, 7%, and 5% of the variance in spatial performance in Studies 1, 2, and 3, respectively. In comparison, sex accounted for 1%, 7%, and 3% of the variance in Studies 1, 2, and 3, respectively. Thus, even small differences in activity preferences may help explain the commonly observed sex differences on spatial tasks.

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